

“Studies in the Morphology of Spore-producing Members. IV.
The Leptosporangiate Ferns.” By F. O. BOWER, Sc.D., F.R.S.,
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(Abstract.)

The characters used in current classifications of Ferns need strengthening. In recent years the more detailed knowledge of the prothallus has been used for this purpose, but while not denying its value in certain specific cases, the author holds that the vegetative development of the prothallus is an uncertain guide to a general classification. On the other hand the archegonium is so uniform in its character that it gives little help; the comparison of the antheridium is, however, a useful aid, though not sufficiently varied to serve in detail.* Accordingly the sporophyte must be the main basis. Its vegetative organs have lately been largely used for systematic purposes by Christ;† but the same objection holds here as in Phanerogams to the use of these as characters of first rank for comparison. An attempt has therefore been made in this memoir to strengthen the characters derived from the sorus by a fresh examination of its details, and certain of its features will now be used for purposes of general comparison, which have hitherto received too little attention; they are:—

1. The relative time of appearance of sporangia of the same sorus.
2. Certain details of structure of the sporangium, including its stalk.
3. The orientation of the sporangia relatively to the whole sorus.
4. The potential productiveness of the sporangium as estimated by its spore-mother cells, and the actual spore-output.

Observations of these features extending over all the more important living genera, coupled with data of habit and the characters of the Gametophyte as collateral evidence, have led the author to divide the homosporous Ferns thus:—

Simplices	{	Marattiaceæ	}	Eusporangiate
		Osmundaceæ		
		Schizæaceæ		
		Gleicheniaceæ		
		Matonineæ		
Gradatæ	{	Loxsomaceæ	}	Leptosporangiate
		Hymenophyllaceæ		
		Cyatheaceæ		
		Dicksoniæ		
		Dennstædtiineæ		
Mixtæ ...	{	The bulk of the	}	
		Polypodiaceæ		

* Heim, ‘Flora,’ 1896, p. 355, &c.

† ‘Die Farrnkräuter der Erde,’ Jena, 1897.

These divisions are primarily based on the order of appearance of the sporangia in the sorus, the Simplices having all the sporangia of the sorus formed simultaneously, the Gradatæ having them disposed in basipetal succession, and the Mixtæ having the sporangia of different ages intermixed. But it is found that other important characters run parallel with these: thus the Simplices and Gradatæ have an oblique annulus (where definitely present), the Mixtæ (with very few exceptions) have a vertical annulus. None of the Mixtæ have been found to have a higher spore-output per sporangium than sixty-four, but this number is exceeded by some of the Gradatæ, and large numbers are the rule in the Simplices. The Simplices and Gradatæ have relatively short thick stalks, the Mixtæ usually have long and thin stalks. The orientation of the sporangia in the Simplices and Gradatæ is usually definite, in the Mixtæ it is indefinite. The receptacle is often elongated in the Gradatæ, but not in the Simplices or Mixtæ. The sum of these characters, which for the most part run parallel to one another, appears to give a substantial basis to the classification.

Evidence as to the transition from type to type has been collected. In the case of the transition from a simultaneous to a successive sorus it does not amount to a demonstration: but it is specially pointed out how slight a step it is from such a sorus as that of *Gleichenia dichotoma* to that of an *Alsophila*: that given a basal indusium and marginal position, the similarity of sporangial structure and dehiscence between *Gleichenia* and *Loxosoma* is suggestive; as also the sporangial structure and high spore-output in *Hymenophyllum*. Though we may recognise these lines of similarity, they do not focus upon any one genus as the actual transitional link from the simultaneous to the basipetal. But the transition from the basipetal to the mixed sorus can be followed in detail; intermediate steps are seen in the Dennstaedtiinæ, while the fully mixed type is seen in the closely allied *Davallia*. Probably this is only one of several such lines of transition from the basipetal to the mixed type.

It is shown that a biological advantage would be gained by the suggested transitions. In the Simplices the few sporangia are large, and, arising simultaneously, make a demand all at once on the nutritive resources of the part. In the Gradatæ the smaller sporangia are produced in succession upon an elongating receptacle, and the drain on the part is spread over a longer period. But with the assumption of the mixed character the drain may be spread over an equally long time, while, as the elongated receptacle disappears, the surface from which nourishment can be derived is enlarged, and the distance through which it has to be transferred is shortened. Thus it appears biologically reasonable that the succession should be as suggested.

It is shown how the various types of dehiscence, and the action of the annulus stand in close relation to the orientation of the sporangia,

and to their arrangement in the sorus. Thus the position of the annulus, which has played so important a part in classification, has been placed upon a footing of adaptation.

Estimates of numerical output of spores per sporangium have been made with a view to illustrating the relation of the Eusporangiate and Leptosporangiate ferns in this respect. The estimated output in the Marattiaceæ has been shown to be high;* that of the Polypodiaceæ is sixty-four or less. The result of numerous countings is to show that, of all Leptosporangiate ferns, *Gleichenia* approaches most nearly to the Marattiaceæ (*Gl. flabellata* may produce over 800 per sporangium); *Osmunda* may have over 500, and *Lygodium* 256. The most interesting results were derived from the Hymenophyllaceæ, in which *Hym. tunbridgense* may have over 400, while species of *Trichomanes* may produce as few as thirty-two per sporangium. These results, when taken with those derived from the filmy *Todeas*, make it seem probable that the filmy habit is a condition leading to reduction of output per sporangium, and indicate that the Hymenophyllaceæ are a derivative series of reduction.

A most important commentary upon the classification proposed is derived from comparison of the antheridia, which Heim† found to be the most dependable part of the Gametophyte for comparative purposes. He recognises two types according to their dehiscence: the one type includes, with the exception of two genera of Schizæaceæ, our Simplices and Gradatæ, while the other includes the Mixtæ. I can only regard this correspondence of parts, so aloof from one another as the antheridium and the sporangium, as establishing the relations of the Simplices and Gradatæ upon a firmer footing; the facts also give substantial support to the distinction of the Gradatæ and Mixtæ.

The effect of the observations and comparisons in this memoir is rather confirmatory of the current classifications than disturbing. The divisions suggested would supersede those of Eusporangiatæ and Leptosporangiatæ, though these terms would still be retained in a descriptive sense. If the sub-orders Osmundaceæ, Schizæaceæ, and Marattiaceæ be transferred from the end of the Synopsis Filicum to the beginning, and grouped with *Gleichenia* and *Matonia*, we have the "Simplices" before us. The Gradatæ include the Cyatheaceæ, Dicksoniæ (*Excl. Dennstaedtia*), Hymenophyllaceæ, and Loxsomaceæ, sequences probably of distinct descent, and, in my view, derivative from some prior forms such as the Simplices; and in the arrangement of Sir Wm. Hooker they hold a position following on the Gleicheniaceæ. The family of Dennstaedtiinæ, founded by Prantl to include *Dennstaedtia* and *Microlepium*, also has its place here, but it leads on by intermediate steps to undoubtedly mixed forms such as *Davallia*,

* 'Studies,' No. 3, p. 60.

† 'Flora,' 1896, p. 355, &c.

Cystopteris, *Lindsaya*, and the *Pterideæ*. But this sequence is already laid out in this order in the Synopsis, and it illustrates one at least of the lines along which mixed forms are believed to have been derived from the *Gradatæ*. No attempt has been made to follow the natural grouping of the *Mixtæ* into detail, or to test the arrangement of them in the Synopsis. Sufficient has, however, been said to show that the systematic divisions of the ferns now proposed fall in readily with the system of Sir William Hooker, notwithstanding that they are based upon details of which he cannot have been aware.

“Note on the Fertility of different Breeds of Sheep, with Remarks on the Prevalence of Abortion and Barrenness therein.” By WALTER HEAPE, M.A., Trinity College, Cambridge. Communicated by W. F. R. WELDON, F.R.S. Received March 9,—Read April 20, 1899.

The importance of fertility as a factor in the survival of a species is admirably demonstrated by Haffkine,* whilst Professor Karl Pearson† shows that fertility when correlated with other characteristics works a progressive change, and that not only is fertility a race characteristic, but may be a class characteristic in the human species.

Among domesticated animals, although fertility may be a racial characteristic, its importance may be much reduced from a variety of circumstances.

Among sheep there is undoubted evidence of the racial character of fertility, but the quality of the wool or the value of fat sheep of a particular breed may render that breed worth keeping in spite of a low rate of fertility as compared with other breeds. Then the rate of fertility may be artificially increased, as when certain rams of undoubted value as progenitors, but useless as breeders if left to themselves, become valuable sires by the help of the shepherd. In the same way a certain breed of sheep, kept in one district and managed in a particular manner, may be more liable to abortion, or to barrenness, or to mortality among the lambs, than the same breed in another district managed in another way, and yet the former may, on account of the supply of food which it is possible to grow there per acre, prove the most remunerative.

From these and many other similar reasons the survival of a particular breed or its retention in, or importation to, a particular district is not necessarily due to natural fitness or adaptability. At the same time a

* “Recherches sur l'adaptation au milieu chez les Infusoires et les Bactéries; contribution à l'étude de l'immunité,” ‘Annales de l'Institut Pasteur,’ vol. 4, 1890.

† “Contributions to the Mathematical Theory of Evolution. Note on Reproductive Selection,” ‘Roy. Soc. Proc.,’ vol. 59, 1896.